Redesigning Genomics - Reconstructing Societies

Puente Rodriguez, D.

2010

document version
Publisher's PDF, also known as Version of record

Summary

Genomics is a brainchild of the high-tech, knowledge intensive mode of production of Western economies. Not surprisingly, within agriculture, the developmental path of biotechnologies generally and genomics in particular is dictated by agribusiness and public research institutes generally based on the Western world, and mainly oriented towards commercial agriculture. The great mass of the world's poor and the rural structures they inhabit and operate, peasants and their agrarian systems, are typically excluded from this developmental path. In this thesis, this type of development is labelled *deterritorializing* (in Chapter 1). It is deterritorializing insofar as it excludes the local people and their socio political structures from the biotechnological decision-making process. In the rural third world, furthest from the techno-economic centres of power, this means that peasants, civil society organizations and local researchers have little or no voice in science and technology R&D processes that may affect them more than anyone. As a consequence, when genomics is presented as a technology which could work for development, an approach based on the straightforward transfer of technology is usually assumed as the means to achieve this.

Taking this analysis as normative, our present day conventional reality, the present research has searched for alternative, *territorial trajectories* for the development of biotechnologies aimed at strengthening peasant agrarian systems, and at empowering local groups within biotechnological systems. These territorial alternatives are captured under the concept of *local sustainable biotechnological developments*. Local sustainable biotechnological development is defined as *a type of development based on the reconstruction of biotechnologies mainly (though not exclusively) by and for local actors, and which strengthen peasant agrarian systems and empowers peasants, civil society organizations and local researchers within biotechnological structures.*

Local sustainable biotechnological development is described (in Chapter 2) as encompassing two core elements – (bio)technology and territoriality. *Technology* is here defined as a social structure, a system formed by social and material elements, which has politics. This builds on Critical Theory approaches to technology (e.g. Andrew Feenberg), and forms of constructivism, including Social Construction of Technology (e.g. Wiebe Bijker, Thomas P. Hughes and Trevor Pinch), Social Shaping of Technology (e.g. Donald MacKenzie and Judy Wajcman), and Actor Network Theory (e.g. Bruno Latour). The theoretical frame of reference for the politics of *biotechnologies* is concerned with the historical processes of the industrialization (e.g. David Goodman, Bernardo Sorj, and John Wilkinson), scientification (Jan Douwe van der Ploeg) and biotechnologization (Guido Ruivenkamp) of agriculture. This research suggests that rather than assuming a unilinear path for the development of (bio)technologies (the dominant conventional path described), multiplicity and variety may be considered feasible, with different technological trajectories applicable and appropriate for different – and within – given territory(s).

Territoriality is formed by two main elements, power and locality. Within the context of biotechnology development, territoriality is here defined as the power exercised by local actors on biotechnological developments. In this regard, the conceptual frameworks employed are territoriality (Robert David Sack, and Alberto Magnaghi), alternative development approaches (Alberto Magnaghi, Björn Hettne, or John Friedmann), and tailor made biotechnologies (Guido

Ruivenkamp). In this context, the case studies addressed here are presented as illustrations of biotechnological developments that can strengthen peasant agrarian systems, and in which power is, to a certain extent, exercised by local actors.

The concept Local sustainable biotechnological developments is situated at the intersection of territory and biotechnology; it is concerned with the exercise of power by local actors on biotechnological developments. It is argued here that a territorial approach to biotechnology development should consider at least three interrelated analytic domains:

1. The *territorial domain* concerns the social dimensions of *power and locality* for the development of biotechnologies. It involves the study of the socio-political dynamics engaged by multi-stakeholder networks to address the agrarian problems of peasants in a given territory through biotechnology. It tests the horizontality (the, to a certain extent, non-hierarchical structuring) of the social relations between the different social groups involved in biotechnological developments by looking at whether and how (mainly) peasants, civil society organizations, and local researchers are included in them.
2. The *technological domain* analyzes *power and the material dimensions of technology*. It explores the material changes that are required for the local specific (territorial) development of biotechnologies. Actually, insofar as the material level is partially a function of the political (qua the power dimension of technology), it is closely interrelated with the social, the two are co-constructive of each other within socio-technological structures. They are differentiated and considered here separately purely for ease and clarity of analysis.
3. The *reterritorialization domain* focuses on the *empowerment of territories* regarding biotechnological developments. It studies the position in which 'local sustainable biotechnological developments' place the territories where they occur in respect of future negotiations for biotechnology development. In this way, it reflects on how the process of territorializing biotechnologies generates new socio-technological structures which strengthen peasant agrarian systems and the position of peasants, civil society organizations, and local researchers within biotechnological structures. It also reflects on the new dynamics that this type of development brings about within the historical context of an increasing industrialization and biotechnologization of agriculture.

There have been many theoretically based studies that argue that genomics could invigorate the agrarian practices of peasants, but rather less research has been conducted into the actual application of genomics within specific peasant agrarian systems. This research has attempted to contribute to filling the gap in this area by studying the potentialities and challenges that emerge from the development of certain biotechnologies within specific peasant territories. Three case studies have been analyzed.

Case 1 (Chapter 3): *Territorializing the production of a* Bacillus thuringiensis *biopesticide within the context of peasant agriculture in Andhra Pradesh, India*

This case study explores the development of biopesticides for pest-management in the peasant agrarian systems of the semiarid districts of Mahaboobnagar and Nalgonda, in the state of Andhra Pradesh, India. In these territories, the main cultivated crop is castor (*Ricinus communis*), and the castor semilooper (*Achea janata*) one of the most important pests. The majority of chemical and bio-pesticides available in the locality to address the problem of the heavy losses to castor

production caused by the semilooper are unaffordable and/or unsuitable for peasant practices. This case study looks at how the human and material resources of the territory are mobilized to address castor semilooper through biotechnological means. Based on local strains of the soil bacteria Bt (*Bacillus thuringiensis*) effective against the semilooper – strains studied with genomics technologies –; multi-stakeholder networks of peasant groups and civil society organizations, public research institutes, and agricultural extension systems have developed a new process to produce a Bt-spray to manage the pest which is cost-effective and which requires small-scale technical capacities that can be reproduced at the village level. Further to this, a decentralized system of production-units has been established in some villages to manufacture and distribute the Bt-spray. A system employed also for the manufacture of other biopesticides and biofertilisers which are adapted to local needs and capacities.

This case study also focuses on the material redesign process of production of Bt-biopesticides in the form of sprays. Bt-sprays are normally produced by a liquid-state fermentation process, but the network has developed a new production process employing a solid-state fermentation. This redesign makes possible the production of the Bt biopesticide at the village level in the aforementioned production units. The case shows that the social and material rearrangements around the Bt-spray create a new understanding, both of the territory and of the development of biotechnologies. Biotechnologies are not longer created far away and 'parachuted' into peasant territories, but are developed from the bottom-up, according to the local perception of needs and assessment of optimum techniques and procedures by local peasants, and civil society organizations, empowered, thereby, in the development of pest-management technologies, and also within their own territory.

Case 2 (Chapter 4): *The Wiphala Genomics: the territorialization of molecular markers in small-scale potato crop systems in the Bolivian Andes*

The second case study addresses the deployment of molecular markers within the small-scale and highland potato crop systems of the departments of Cochabamba and Norte de Potosí in the Bolivian Andes. In these territories, the wealthy diversity of peasants' potato varieties is essential for the survival of peasant households, as this diversity is used strategically to produce potatoes in the high-diverse ecosystems of the Andean Highlands. Moreover, potato diversity also has an important cultural meaning for the Quechua and Aymara populations living in these territories. Unfortunately, this diversity is apparently decreasing.

This case study outlines two contradictory understandings of potato diversity. On the one hand, potato biodiversity is understood in terms of raw materials, according to which peasants' varieties have no intrinsic value, the value of (new/different) varieties being something created (added) by breeders in breeding projects. On the other hand, biodiversity is understood as cultural material, according to which, potatoes are final entities produced by peasants and which therefore do have an intrinsic value. It is argued that the development of biotechnologies aimed at addressing the problems of local varieties would be beneficial from the territorial perspective of community survival and empowerment as well as the global perspective of maintaining (developing) diversity. Therefore, it is suggested that the deployment of molecular markers within the cultural understanding of biodiversity – termed the 'Wiphala Genomics' – has potentialities to address some agrarian constraints of resource-poor farmers. Furthermore, some participatory plant breeding networks are found as appropriate social platforms (*environments*) for the deployment of molecular markers, platforms which are already shaping the Wiphala Genomics.

This case study also explores the material readjustments that molecular markers need to undergo in order to be able to properly perform within the Bolivian territories. Ultimately, the reflection has to consider the current reality of how, when molecular markers are deployed within a raw material understanding of diversity, peasant potato varieties are extracted from the territory and appropriated by global networks to serve as a basis for plant breeding outside the territory for ends that, predictably enough, do not serve the territory itself. Within the social environment for the development of the Wiphala Genomics, however, Quechua and Aymara peasants are empowered, and the conservation and development of potato genetic variety and productive diversity are strengthened. By deploying molecular markers with a specific social and technical code the developmental capacities of these Andean territories can be strengthened.

Case 3 (Chapter 5): *Biotechnologizing Jatropha for local sustainable developments in Yoro, Honduras*

Against the background of an expanding biofuels regime within agriculture, the third case explores the ongoing efforts of local multi-stakeholder networks formed by peasant groups, NGOs, and research institutes in the department of Yoro, Honduras to give a new energy meaning to *Jatropha*, a shrub-like plant traditionally used more for other purposes (such as in 'living fences' for cattle, for soap production, and medical usage). The socio-political organizational structure – the Gota Verde network – that has been constructed for the local and sustainable production and consumption of (Jatropha) biofuel is examined.

This case study also addresses the scientification and biotechnologization process (through genomics) that Jatropha is presently undergoing. With this purpose in mind, a focus is placed on a global oriented genomics network that is working with the plant. Coordinated from the Netherlands, this network is engaged in collaborations with local networks (including the Honduran Gota Verde network) which might lead to an improvement in the local production of Jatropha. Emphasis is given to a detailing of the interaction between these two networks; that is, the analysis here concentrates on how the scientification and biotechnologization process that Jatropha is undergoing might strengthen the local development in Honduras.

Chapter 6 unfolds the conclusions extracted from the case studies in the aforementioned three analytic domains to develop further the concept 'local sustainable biotechnological developments'.

Territorial domain

Local sustainable biotechnological development is an act of territorializing biotechnologies and therefore, genomics. This research argues that the act of territorializing biotechnologies is an act of exercising local power on biotechnological developments. Following Foucault, the suggestion made here is that power is not possessed (like a substance), but exercised (as a dynamic) by a certain organization of social relations. Therefore, a *reorganization of social relations* can *transform power within biotechnological structures*. To begin with, if biotechnologies and genomics are to play a role in strengthening resource-poor farmer agrarian systems, then, the social structures that apply and reproduce these technologies and these sciences need to reorient them toward specific problems affecting those agrarian systems. So far, there have been few relevant genomics developments in this area. Through the involvement of local actors and agrarian systems in biotechnological developments, we see in the three case studies analyzed here

how multi-stakeholder networks are nevertheless addressing some relevant peasant agrarian problems in specific territories.

The three local biotechnological developments addressed here have all been activated by external financial sources. International funding in agrarian biotechnology usually supports impact oriented projects in third world regions around what are seen as relevant global issues. For this reason, it can hinder local research agendas built around locality specific aims. In order to avoid this, it is argued, funding agencies ought to support research structures rather than particular projects. In this way, science could support and facilitate a more sustainable development in these regions of the world. In the facilities of local research structures, new research questions can be elaborated and answered in the form of locality specific research (like the Wiphala Genomics). The research organizations and policy makers of low-income countries, the argument continues, should elaborate strategies based on local conditions and problems with which external agencies can align their research funding. By decentralizing and building local research capacities, sciences and biotechnologies can grow within and strengthen the multitude of existent local agrarian systems. In fact, it is only through such a *decentralized system* development that genomics knowledge and technologies can be properly translated into locality specific applications to the benefit of resource-poor farmers (as opposed to being merely transferred and of questionable benefit, or worse).

Many scholars have argued that science and technology developments are highly context dependent and value laden, and that therefore a wider set of actors needs to be engaged within these developments. The engagement of a wider set of social actors in science and technology developments is not only morally desirable, but can also be more efficient. In the case studies analyzed here we see three multi-stakeholder networks aimed at territorializing genomics' scientific knowledge and biotechnologies within peasant agrarian systems. These networks are breaking through the common monopoly of power on genomics knowledge and technologies exercised by formal scientists in expensive labs. Working in and with the networks explored in this thesis are molecular biologists, plant breeders, agronomists, social scientists, peasants, and civil society practitioners. Different types of information flow through these networks and are translated into different types of knowledge, or into practical technological applications (the local specific Bt-spray, Wiphala Genomics, and Jatropha biofuel). Given that the regular social relationships that structure agro-genomics socio-technological systems are usually unable or unwilling to orient their technological capacities towards peasant agrarian systems, it follows that they – the social relations – need to be restructured. The three case studies addressed outline alternative trajectories for doing so. These trajectories involve including a wider set of social actors (e.g. peasants and civil society organizations), and facilitating the share of knowledge through the democratization and decentralization of science and technology developments.

Technological domain

Power is exercised not only through social relations, but also materialized into apparatuses. Therefore, in order *to democratize the power exercised on biotechnologies, not only is a reorganization of the social relations organized around biotechnological developments required, but also some material readjustments are needed.* Among the material changes analyzed in the case studies, there are some that respond to the incompatibility between genomics functioning requirements and local conditions. Genomics related technologies are usually expensive and often require high specialized skill competences that often cannot be met in low-income labs. These types of changes, it is argued, make the territorialization of genomics an unavoidable step

for such labs, which are frequently the ones that support peasant agrarian systems. A different way of perceiving these material changes addressed here is that they are required for governing genomics from within the locality. For instance, in Chapter 3 we see that in order to be able to produce a Bt-spray that is affordable, accessible, and feasible at village level, the industrial approach for producing Bt-sprays in which Bt spores are multiplied through a liquid-state fermentation has been transformed into a solid-state fermentation. The material changes provoked by the redesign process facilitate the production of the Bt-spray at village level and a decentralized system of production units has generated a new technical code, which includes peasants, civil society organizations, and local researchers and which effectively manages an important pest affecting local agrarian systems. Similarly, Chapter 4 explores some material and clever readjustments that local researchers are implementing in their molecular biology lab in Cochabamba so as to deploy and control genomics – such as the production of local polymerase and ethanol, and the use of conventional kitchen refrigerators rather than the expensive refrigerators recommended by scientific protocols. These types of changes and adaptations are expected in the large majority of molecular biology labs with low economic capacities.

When it comes to deploying high technologies such as genomics within low input science and technology systems that look after resource-poor agrarian systems, *a combination of different types of knowledge (formal and informal) and of technologies (high and low tech)* becomes necessary. Genomics in isolation of other technological system is useless – and most especially for the types of science and technology structures that usually support the agrarian systems of peasants. The Bt-network presented in Chapter 3 is a fascinating example of how low technologies become a vital step in linking genomics developments with peasants' practices.

Due to the complexity and high cost involved in genomics practices, this research argues that *a combined dynamic of research and technology facilities centralization and decentralization* seems *to be necessary in order to link peasant's fields with genomics labs*. In this context, the expensive development of molecular markers, for instance, might best be centralized. This can save costs and guarantee access to some ready-made technologies. However, such centralization does require that the research institution working on genomics development remains in contact with plant-experts all around the world so as to guarantee that the markers that they discover are indeed relevant for specific localities and available in local accessions that show good combining ability with elite cultivars. In contrast, it is the decentralized system of Bt production units in Andhra Pradesh that guaranties peasants access to agrarian technologies and, moreover, the exercise of power on biotechnological developments. The decentralization of science and technologies also results in labs such as the one in Cochabamba (Chapter 4) experimenting with, for example, molecular markers and thereby generating locality specific alternative biotechnological developmental paths (the Wiphala Genomics). The equilibrium between centralization and decentralization in respect of science and technology developments might generate new dynamics for their territorialization and democratization.

The *local specific redesign of biotechnological codes* in which a particular reconfiguration of social forces is aimed at defining a specific road to technology development might appear to some as an intellectual attempt to substitute technological determinism (implicit in the technology transfer approach) with a kind of social determinism. While the social contingency of technologies is fundamental to the theoretical analysis developed here, this is not something that operates in isolation: technologies are also the result of social and material mutual adaptations. Nevertheless, the participation of subordinate social stakeholders in the struggles of writing biotechnological codes can change outcomes. If peasant agrarian systems with their potencies and deficiencies, their peasants, civil society organizations, local communities, and researchers are

considered and given a voice in the decision-making process of agrarian genomics, the probability that genomics will strengthen these systems and that these actors will be empowered within the resulting biotechnological structures is greatly increased.

Reterritorialization domain

Critical literature has studied the structural power that the industrialization and biotechnologization process of agriculture has brought about. Goodman, Sorj, and Wilkinson explore the *industrial appropriation* of farmers' activities like pest or soil management by external institutions, and a parallel development of industrial substitution for rural products; Van der Ploeg explains how through the process of *scientification of agriculture*, agrarian activities and farmer labour are becoming increasingly controlled by scientists' knowledge; while Ruivenkamp argues that through this scientification a process of biotechnologization has taken place in which *control at a distance* is exercised on agrarian labour from the scientific domain through the introduction of politicizing products. Together, these historical processes have led to a *loss of autonomy* on the part of farmers in the performance of their agrarian practices.

The content of technology, it is argued, is not *essentially* destructive; rather, it is a matter of design and further deployment into the social. Agrarian and scientific networks are not just mere receptors of technologies, and therefore they do not automatically reproduce the politics encoded within the technology design. The multi-stakeholder networks analyzed in the three case studies are shown as challenging this structural power of biotechnological developments in the realm of agrarian activities and, to a certain extent, are reversing it towards local sustainable developments. For instance, the *industrial appropriation of farming activities is challenged by the self-organized practices of local multi-stakeholder networks*. The reorganization of the available natural and human resources in Mahaboobnagar and Nalgonda (Andhra Pradesh, India) has been self-managed by the local actors, who, instead of participating in a technology transfer structure and waiting for the next parachuted pesticide technology, have challenged it collectively and politically. The networks 'hacked' into the biotechnological system and turned it to new purposes. Their struggle represents a counter-tendency to *appropriationism*, an attempt to rediscover the caring and communal functions of biotechnology development – caring for the local agrarian problems of peasants, and building new forms of communality in which (bio)technologies (their development) are seen and employed more as catalyst than as a challenge to local development.

The *control at a distance* exercised through the *scientification and biotechnologization* processes *is somewhat reversed by a local specific power exercised over biotechnological developments and agrarian labour (territoriality)*. The cases of the Bolivian Andes and of the Honduran Yoro show how the construction of horizontal global-local structures through which knowledge and technologies can be shared are able to facilitate the development of appropriate and efficient local specific biotechnologies – like the Wiphala Genomics. The demand for, and the practices of communication and democratization of biotechnologies that these movements represent is so fundamental that it can serve as a touchstone for the claim made here for the *polypotency of scientification and biotechnologization processes*. These networks challenge the rationality under which biotechnologies are currently designed. They generate *empowered social environments* for biotechnology development. Within and through these networks, *the dwellers of peasant agrarian systems become empowered engines of biotechnology and of local development.*

One of the desirable outcomes of local sustainable biotechnological developments is argued to be that of *social sustainability*. Magnaghi defines social sustainability as a greater involvement of weak stakeholders in the local decision-making system. Translating this general definition into our biotechnological focus, we might say that the structures that direct biotechnological developments should be sufficiently complex so as to guarantee the participation of weaker social stakeholders and their needs. *Mechanisms have to be created to guarantee that territorial (natural and human) resources are not exploited by the local strongest, or external social actors, and that these resources are used for local equality.* One example of a type of mechanism that can be institutionalized within local developments and might guarantee the participation of social weak groups is given in the third case study. Here a co-operative company owned and controlled by the local fuel crop producers is established for the transformation and distribution of products originated from the Jatropha plant and from other fuel-crops. This type of set-up circumvents the usual process in which the produce of peasants is bought by intermediaries and sent outside of the locality for manufacture and use. Because the manufacturing company in Yoro is in the hands of small-scale Jatropha producers, it follows that the biotechnological trajectory for Jatropha through genomics studied here will orient genomics towards local agrarian needs, including a guarantee that the association of peasants will have a voice in deciding which traits of Jatropha are important. In other words, a locality specific power can be exercised on biotechnological developments (territoriality).

Technology is one of the structures that reproduce territories. It is another political arena in which inclusion and exclusion struggles are fought. Involving the dwellers of a locality in the decision-making negociations about the future of that territory (its constant *reterritorialization*) is a complicated business, but effective in striking a power balance in processes of change. The biotechnological futures and the futures of territories are usually oriented to benefit those social actors with access to the negotiations. The picture of these futures becomes more diverse, fascinating, and fair when less powerful stakeholders acquire a voice, i.e. power. In order to achieve this, one of the codes that might be able to deliver significant positive results is that of Local Sustainable Biotechnological Developments.